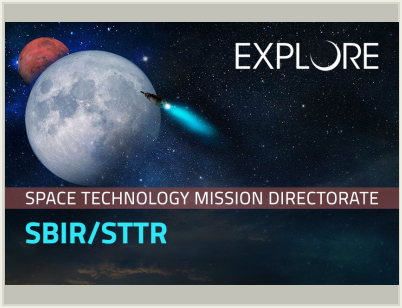
O2/CO Ignition System for Mars Sample Return Missions, Phase I

Completed Technology Project (2014 - 2014)

Project Introduction

Returning a geological sample from the surface of Mars will require an ascent propulsion system with a comparatively large velocity change (delta-V) capability due to the relatively deep Martian gravity well. Consequently, a significant propellant mass will be required. Bringing that mass from Earth, while technically possible, would be impractical and grossly inefficient. Manufacturing propellant from the Martian atmosphere would be far more practical. Highly efficient electrolyzers for splitting carbon dioxide into carbon monoxide (CO) and oxygen (O2) have been demonstrated. These can be run off solar power and used to generate high-pressure propellant without the need for pumps. With a theoretical vacuum specific impulse (Isp) of 324 sec (1000 psia chamber pressure, 40:1 nozzle expansion ratio), an O2/CO propulsion system would provide higher Isp than a solid rocket, and only a small fraction of the propulsion system wet mass would have to be brought from Earth. Previous testing with O2/CO propellant at NASA GRC has demonstrated that ignition of this mixture is very difficult. In that work, spark igniters were used, and every test resulted in a catastrophic detonation and damage to equipment. In this project, Ultramet will develop a high-performance ignition system for use with O2/CO propellant that is based on resistively heated silicon carbide open-cell foam. Previous testing has demonstrated that by passing an electric current through it, the foam can be heated to 1300 C in just 2 seconds. By flowing the non-hypergolic bipropellant mixture through the foam, ignition will take place in a pseudo-homogeneous manner as the gases enter the foam rather than only in the isolated vicinity of the arc in a spark igniter. This will prevent propellant accumulation in the chamber and subsequent detonation. Safe, reliable ignition of O2/CO is an enabling technology for the use of in-situ manufactured propellants on Mars.



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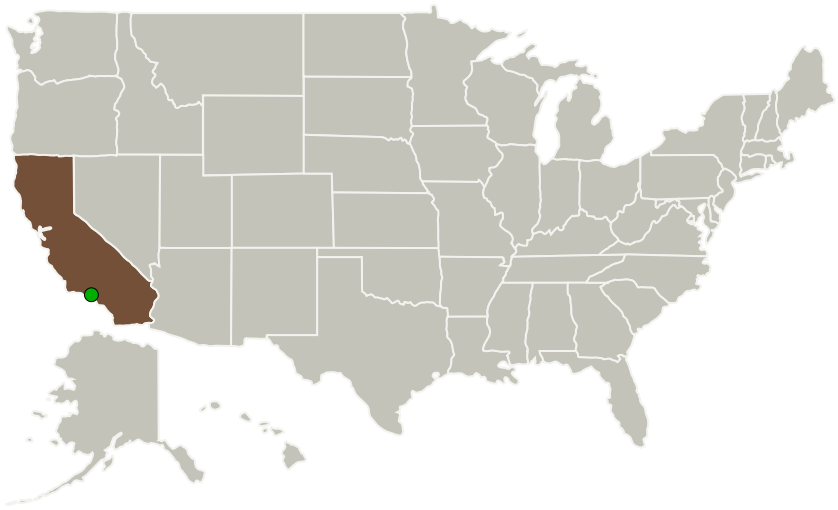
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Ultramet	Lead Organization	Industry	Pacoima, California
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Project Transitions

June 2014: Project Start

December 2014: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137709)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Ultramet

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

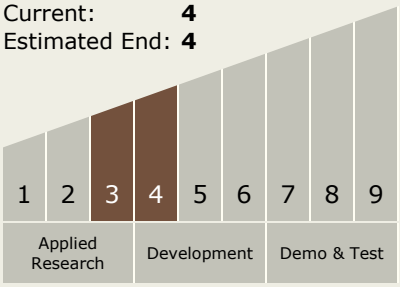
Carlos Torrez

Principal Investigator:

Arthur J Fortini

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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Images

Briefing Chart
O2/CO Ignition System for Mars Sample Return Missions, Phase I *(https://techport.nasa.gov/image/130311)*

Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.1 Chemical Space Propulsion
    - TX01.1.7 Cold Gas

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System